



# Full wwPDB X-ray Structure Validation Report ⓘ

Jan 16, 2021 – 11:33 AM EST

PDB ID : 6XBI  
Title : Crystal structure of the SARS-CoV-2 (COVID-19) main protease in complex with inhibitor UAW248  
Authors : Sacco, M.; Ma, C.; Wang, J.; Chen, Y.  
Deposited on : 2020-06-06  
Resolution : 1.70 Å(reported)

This is a Full wwPDB X-ray Structure Validation Report for a publicly released PDB entry.

We welcome your comments at [validation@mail.wwpdb.org](mailto:validation@mail.wwpdb.org)

A user guide is available at

<https://www.wwpdb.org/validation/2017/XrayValidationReportHelp>

with specific help available everywhere you see the ⓘ symbol.

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The following versions of software and data (see [references ⓘ](#)) were used in the production of this report:

MolProbity : 4.02b-467  
Mogul : 1.8.5 (274361), CSD as541be (2020)  
Xtriage (Phenix) : 1.13  
EDS : 2.16  
Percentile statistics : 20191225.v01 (using entries in the PDB archive December 25th 2019)  
Refmac : 5.8.0158  
CCP4 : 7.0.044 (Gargrove)  
Ideal geometry (proteins) : Engh & Huber (2001)  
Ideal geometry (DNA, RNA) : Parkinson et al. (1996)  
Validation Pipeline (wwPDB-VP) : 2.16

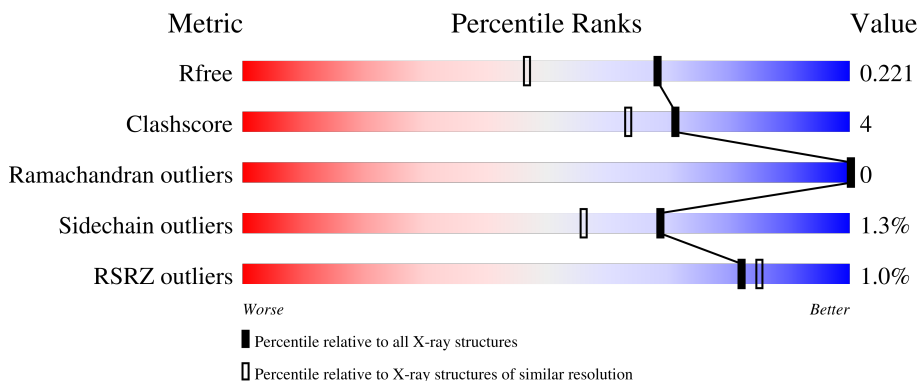
# 1 Overall quality at a glance

The following experimental techniques were used to determine the structure:

*X-RAY DIFFRACTION*

The reported resolution of this entry is 1.70 Å.

Percentile scores (ranging between 0-100) for global validation metrics of the entry are shown in the following graphic. The table shows the number of entries on which the scores are based.



Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
$R_{free}$	130704	4298 (1.70-1.70)
Clashscore	141614	4695 (1.70-1.70)
Ramachandran outliers	138981	4610 (1.70-1.70)
Sidechain outliers	138945	4610 (1.70-1.70)
RSRZ outliers	127900	4222 (1.70-1.70)

The table below summarises the geometric issues observed across the polymeric chains and their fit to the electron density. The red, orange, yellow and green segments of the lower bar indicate the fraction of residues that contain outliers for  $\geq 3$ , 2, 1 and 0 types of geometric quality criteria respectively. A grey segment represents the fraction of residues that are not modelled. The numeric value for each fraction is indicated below the corresponding segment, with a dot representing fractions  $\leq 5\%$ . The upper red bar (where present) indicates the fraction of residues that have poor fit to the electron density. The numeric value is given above the bar.

Mol	Chain	Length	Quality of chain
1	A	308	<div> <div>2%</div> <div> <div></div> <div>91%</div> <div>8%</div> </div> </div>
1	B	308	<div> <div>91%</div> <div>7%</div> <div>..</div> </div>
2	D	5	<div> <div>60%</div> <div>40%</div> </div>
2	E	5	<div> <div>60%</div> <div>40%</div> </div>

## 2 Entry composition

There are 6 unique types of molecules in this entry. The entry contains 5283 atoms, of which 0 are hydrogens and 0 are deuteriums.

In the tables below, the ZeroOcc column contains the number of atoms modelled with zero occupancy, the AltConf column contains the number of residues with at least one atom in alternate conformation and the Trace column contains the number of residues modelled with at most 2 atoms.

- Molecule 1 is a protein called 3C-like proteinase.

Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
1	A	307	Total	C	N	O	S	0	7	0
			2404	1518	410	453	23			
1	B	304	Total	C	N	O	S	0	6	0
			2394	1510	414	446	24			

There are 4 discrepancies between the modelled and reference sequences:

Chain	Residue	Modelled	Actual	Comment	Reference
A	-1	HIS	-	expression tag	UNP P0DTD1
A	0	MET	-	expression tag	UNP P0DTD1
B	-1	HIS	-	expression tag	UNP P0DTD1
B	0	MET	-	expression tag	UNP P0DTD1

- Molecule 2 is a protein called inhibitor UAW248.

Mol	Chain	Residues	Atoms				ZeroOcc	AltConf	Trace
2	D	5	Total	C	N	O	0	0	0
			42	30	5	7			
2	E	5	Total	C	N	O	0	0	0
			42	30	5	7			

- Molecule 3 is GLYCEROL (three-letter code: GOL) (formula: C<sub>3</sub>H<sub>8</sub>O<sub>3</sub>).

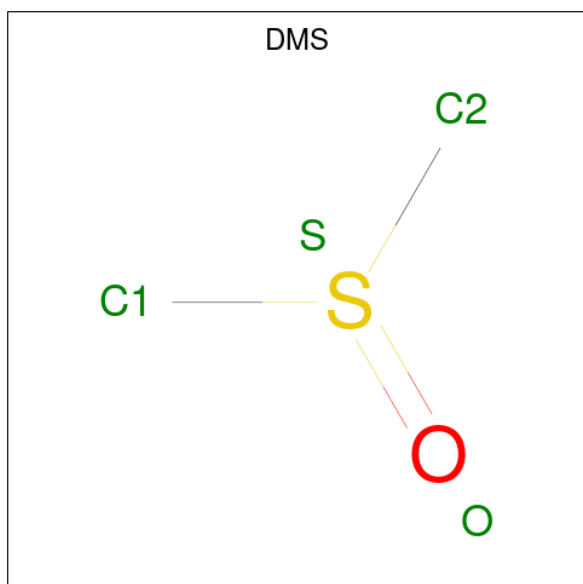


Mol	Chain	Residues	Atoms			ZeroOcc	AltConf
3	A	1	Total	C	O	0	0
			6	3	3		
3	A	1	Total	C	O	0	0
			6	3	3		

- Molecule 4 is SODIUM ION (three-letter code: NA) (formula: Na).

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
4	A	1	Total	Na	0	0
			1	1		

- Molecule 5 is DIMETHYL SULFOXIDE (three-letter code: DMS) (formula: C<sub>2</sub>H<sub>6</sub>OS).



Mol	Chain	Residues	Atoms				ZeroOcc	AltConf
5	B	1	Total	C	O	S	0	0
			4	2	1	1		

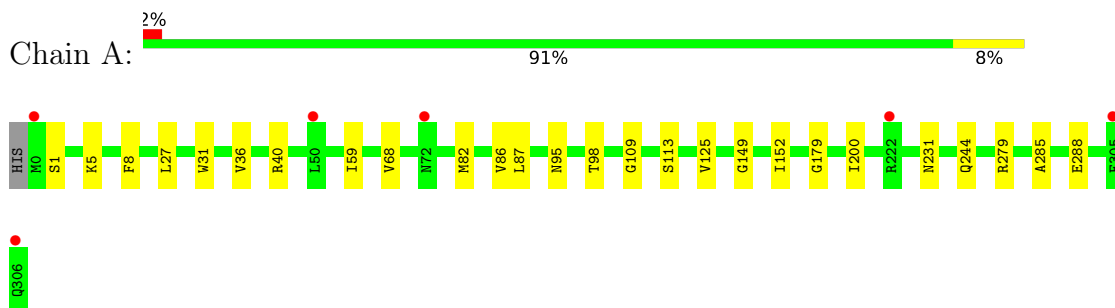
- Molecule 6 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
6	A	184	Total	O	0	3
			187	187		
6	B	189	Total	O	0	6
			196	196		
6	E	1	Total	O	0	0
			1	1		

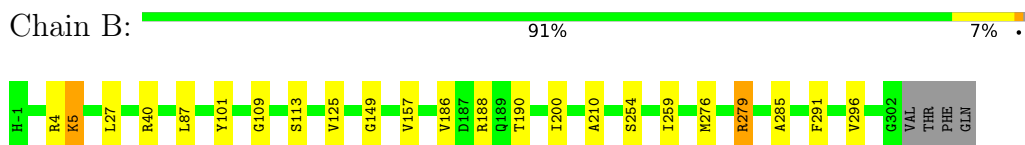
### 3 Residue-property plots [i](#)

These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry and electron density. Residues are color-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. A red dot above a residue indicates a poor fit to the electron density ( $RSRZ > 2$ ). Stretches of 2 or more consecutive residues without any outlier are shown as a green connector. Residues present in the sample, but not in the model, are shown in grey.

- Molecule 1: 3C-like proteinase



- Molecule 1: 3C-like proteinase



- Molecule 2: inhibitor UAW248



- Molecule 2: inhibitor UAW248



## 4 Data and refinement statistics

Property	Value	Source
Space group	P 1	Depositor
Cell constants a, b, c, $\alpha$ , $\beta$ , $\gamma$	46.90Å 54.90Å 62.26Å 60.63° 79.77° 88.83°	Depositor
Resolution (Å)	47.75 – 1.70 47.70 – 1.70	Depositor EDS
% Data completeness (in resolution range)	90.0 (47.75-1.70) 90.0 (47.70-1.70)	Depositor EDS
$R_{merge}$	0.08	Depositor
$R_{sym}$	(Not available)	Depositor
$\langle I/\sigma(I) \rangle$ <sup>1</sup>	2.33 (at 1.70Å)	Xtriage
Refinement program	REFMAC 5.8.0258	Depositor
R, $R_{free}$	0.173 , 0.217 0.182 , 0.221	Depositor DCC
$R_{free}$ test set	2623 reflections (5.00%)	wwPDB-VP
Wilson B-factor (Å <sup>2</sup> )	23.6	Xtriage
Anisotropy	0.483	Xtriage
Bulk solvent $k_{sol}$ (e/Å <sup>3</sup> ), $B_{sol}$ (Å <sup>2</sup> )	0.34 , 42.8	EDS
L-test for twinning <sup>2</sup>	$\langle  L  \rangle = 0.50$ , $\langle L^2 \rangle = 0.33$	Xtriage
Estimated twinning fraction	No twinning to report.	Xtriage
$F_o, F_c$ correlation	0.96	EDS
Total number of atoms	5283	wwPDB-VP
Average B, all atoms (Å <sup>2</sup> )	28.0	wwPDB-VP

Xtriage's analysis on translational NCS is as follows: *The largest off-origin peak in the Patterson function is 9.05% of the height of the origin peak. No significant pseudotranslation is detected.*

<sup>1</sup>Intensities estimated from amplitudes.

<sup>2</sup>Theoretical values of  $\langle |L| \rangle$ ,  $\langle L^2 \rangle$  for acentric reflections are 0.5, 0.333 respectively for untwinned datasets, and 0.375, 0.2 for perfectly twinned datasets.

## 5 Model quality [i](#)

### 5.1 Standard geometry [i](#)

Bond lengths and bond angles in the following residue types are not validated in this section: GOL, NA, DMS, UZ4, UZ7, UZ1

The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with  $|Z| > 5$  is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Chain	Bond lengths		Bond angles	
		RMSZ	$\# Z  > 5$	RMSZ	$\# Z  > 5$
1	A	0.71	0/2459	0.88	0/3343
1	B	0.73	0/2446	0.87	0/3321
2	D	1.29	0/15	1.80	0/19
2	E	1.23	0/15	1.25	0/19
All	All	0.72	0/4935	0.88	0/6702

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

There are no planarity outliers.

### 5.2 Too-close contacts [i](#)

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in the chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, whereas Symm-Clashes lists symmetry-related clashes.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	2404	0	2332	19	0
1	B	2394	0	2335	15	0
2	D	42	0	21	0	0
2	E	42	0	21	2	0
3	A	12	0	16	2	0
4	A	1	0	0	0	0
5	B	4	0	6	0	0
6	A	187	0	0	8	0
6	B	196	0	0	0	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
6	E	1	0	0	0	0
All	All	5283	0	4731	34	0

The all-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The all-atom clashscore for this structure is 4.

All (34) close contacts within the same asymmetric unit are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
2:E:1:UZ7:O09	2:E:1:UZ7:C10	1.66	1.39
2:E:1:UZ7:C07	2:E:1:UZ7:C10	2.64	0.75
1:A:288:GLU:CD	6:A:616:HOH:O	2.28	0.71
1:B:5:LYS:HD3	1:B:291:PHE:CZ	2.26	0.70
1:B:188:ARG:HG3	1:B:190:THR:HG22	1.75	0.69
1:A:231:ASN:HB2	3:A:501:GOL:H2	1.78	0.65
1:B:276:MET:O	1:B:279[A]:ARG:HD3	2.08	0.54
1:B:40:ARG:HA	1:B:87:LEU:HG	1.89	0.54
1:B:186:VAL:HG23	1:B:188:ARG:HG2	1.90	0.52
1:A:40:ARG:HA	1:A:87:LEU:HG	1.94	0.50
1:B:276:MET:HE2	1:B:279[B]:ARG:O	2.11	0.50
1:A:231:ASN:CB	3:A:501:GOL:H2	2.44	0.48
1:B:254:SER:HB2	1:B:259:ILE:O	2.15	0.46
1:A:109:GLY:HA2	1:A:200:ILE:HD13	1.97	0.46
1:B:210:ALA:HB2	1:B:296:VAL:HG13	1.96	0.46
1:A:288:GLU:CG	6:A:616:HOH:O	2.63	0.45
1:A:279:ARG:O	6:A:601:HOH:O	2.21	0.45
1:A:82:MET:HE2	1:A:87:LEU:HD21	1.98	0.45
1:A:288:GLU:HG3	6:A:616:HOH:O	2.16	0.44
1:A:86:VAL:HG13	1:A:179:GLY:HA2	2.00	0.44
1:A:285:ALA:HB3	1:B:285:ALA:HB3	2.01	0.43
1:B:109:GLY:HA2	1:B:200:ILE:HD13	2.01	0.43
6:A:614:HOH:O	1:B:4:ARG:CD	2.66	0.43
1:A:31:TRP:CD2	1:A:95:ASN:HB2	2.55	0.42
1:A:59:ILE:HG23	6:A:606:HOH:O	2.19	0.42
6:A:614:HOH:O	1:B:4:ARG:NH1	2.53	0.42
1:B:101:TYR:HA	1:B:157:VAL:O	2.19	0.42
1:A:113:SER:O	1:A:149:GLY:HA2	2.21	0.41
1:A:244:GLN:OE1	6:A:602:HOH:O	2.22	0.41
1:A:95:ASN:HB3	1:A:98:THR:OG1	2.20	0.41
1:B:113:SER:O	1:B:149:GLY:HA2	2.21	0.41
1:A:125:VAL:HG11	1:B:125:VAL:HG11	2.02	0.41

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:8:PHE:HB3	1:A:152:ILE:HD12	2.04	0.40
1:A:36:VAL:HG21	1:A:68:VAL:HG11	2.04	0.40

There are no symmetry-related clashes.

## 5.3 Torsion angles [i](#)

### 5.3.1 Protein backbone [i](#)

In the following table, the Percentiles column shows the percent Ramachandran outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the backbone conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	A	312/308 (101%)	304 (97%)	8 (3%)	0	100	100
1	B	308/308 (100%)	300 (97%)	8 (3%)	0	100	100
All	All	620/616 (101%)	604 (97%)	16 (3%)	0	100	100

There are no Ramachandran outliers to report.

### 5.3.2 Protein sidechains [i](#)

In the following table, the Percentiles column shows the percent sidechain outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the sidechain conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles	
1	A	266/265 (100%)	263 (99%)	3 (1%)	73	63
1	B	265/265 (100%)	261 (98%)	4 (2%)	65	51
2	D	2/2 (100%)	1 (50%)	1 (50%)	0	0
2	E	2/2 (100%)	2 (100%)	0	100	100
All	All	535/534 (100%)	527 (98%)	8 (2%)	69	51

All (8) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	1	SER
1	A	5	LYS
1	A	27	LEU
1	B	5	LYS
1	B	27	LEU
1	B	279[A]	ARG
1	B	279[B]	ARG
2	D	2	LEU

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (1) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	74	GLN

### 5.3.3 RNA ⓘ

There are no RNA molecules in this entry.

## 5.4 Non-standard residues in protein, DNA, RNA chains ⓘ

2 non-standard protein/DNA/RNA residues are modelled in this entry.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the Chemical Component Dictionary. The Link column lists molecule types, if any, to which the group is linked. The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with  $|Z| > 2$  is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\# Z  > 2$	Counts	RMSZ	$\# Z  > 2$
2	UZ4	D	4	1,2	11,13,14	3.09	3 (27%)	10,17,19	1.92	4 (40%)
2	UZ4	E	4	1,2	11,13,14	2.95	1 (9%)	10,17,19	2.18	4 (40%)

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
2	UZ4	D	4	1,2	-	2/9/20/22	0/1/1/1
2	UZ4	E	4	1,2	-	1/9/20/22	0/1/1/1

All (4) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	E	4	UZ4	C26-N25	9.14	1.43	1.33
2	D	4	UZ4	C26-N25	9.12	1.43	1.33
2	D	4	UZ4	O29-C28	-2.47	1.38	1.43
2	D	4	UZ4	C21-C20	2.35	1.57	1.53

All (8) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(°)	Ideal(°)
2	E	4	UZ4	O29-C28-C31	-4.17	100.25	110.08
2	D	4	UZ4	O27-C26-N25	3.57	130.50	125.54
2	E	4	UZ4	O29-C28-C20	-3.52	101.72	107.31
2	D	4	UZ4	O29-C28-C31	-3.27	102.37	110.08
2	E	4	UZ4	O27-C26-N25	3.19	129.97	125.54
2	D	4	UZ4	O27-C26-C22	-2.46	123.35	126.23
2	D	4	UZ4	O29-C28-C20	-2.29	103.68	107.31
2	E	4	UZ4	O27-C26-C22	-2.08	123.79	126.23

There are no chirality outliers.

All (3) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
2	D	4	UZ4	N19-C20-C28-C31
2	D	4	UZ4	C21-C20-C28-C31
2	E	4	UZ4	N19-C20-C28-C31

There are no ring outliers.

No monomer is involved in short contacts.

## 5.5 Carbohydrates

There are no monosaccharides in this entry.

## 5.6 Ligand geometry

Of 4 ligands modelled in this entry, 1 is monoatomic - leaving 3 for Mogul analysis.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the Chemical Component Dictionary. The Link column lists molecule types, if any, to which the group is linked. The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with  $|Z| > 2$  is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\# Z  > 2$	Counts	RMSZ	$\# Z  > 2$
5	DMS	B	501	-	3,3,3	0.31	0	3,3,3	0.12	0
3	GOL	A	501	-	5,5,5	0.17	0	5,5,5	0.50	0
3	GOL	A	502	-	5,5,5	0.12	0	5,5,5	0.37	0

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
3	GOL	A	501	-	-	4/4/4/4	-
3	GOL	A	502	-	-	2/4/4/4	-

There are no bond length outliers.

There are no bond angle outliers.

There are no chirality outliers.

All (6) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	A	501	GOL	O1-C1-C2-C3
3	A	501	GOL	C1-C2-C3-O3
3	A	502	GOL	O1-C1-C2-O2
3	A	502	GOL	O1-C1-C2-C3
3	A	501	GOL	O1-C1-C2-O2
3	A	501	GOL	O2-C2-C3-O3

There are no ring outliers.

1 monomer is involved in 2 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	A	501	GOL	2	0

## 5.7 Other polymers [i](#)

There are no such residues in this entry.

## 5.8 Polymer linkage issues [i](#)

There are no chain breaks in this entry.

## 6 Fit of model and data [i](#)

### 6.1 Protein, DNA and RNA chains [i](#)

In the following table, the column labelled ‘#RSRZ> 2’ contains the number (and percentage) of RSRZ outliers, followed by percent RSRZ outliers for the chain as percentile scores relative to all X-ray entries and entries of similar resolution. The OWAB column contains the minimum, median, 95<sup>th</sup> percentile and maximum values of the occupancy-weighted average B-factor per residue. The column labelled ‘Q< 0.9’ lists the number of (and percentage) of residues with an average occupancy less than 0.9.

Mol	Chain	Analysed	<RSRZ>	#RSRZ>2	OWAB(Å <sup>2</sup> )	Q<0.9
1	A	307/308 (99%)	-0.11	6 (1%) 65 69	14, 27, 48, 69	4 (1%)
1	B	304/308 (98%)	-0.27	0 100 100	14, 25, 47, 61	1 (0%)
2	D	2/5 (40%)	-0.18	0 100 100	23, 23, 23, 27	0
2	E	2/5 (40%)	-0.28	0 100 100	23, 23, 23, 27	0
All	All	615/626 (98%)	-0.19	6 (0%) 82 85	14, 26, 47, 69	5 (0%)

All (6) RSRZ outliers are listed below:

Mol	Chain	Res	Type	RSRZ
1	A	0	MET	3.8
1	A	306	GLN	3.3
1	A	72	ASN	2.8
1	A	50	LEU	2.5
1	A	222	ARG	2.2
1	A	305	PHE	2.0

### 6.2 Non-standard residues in protein, DNA, RNA chains [i](#)

In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95<sup>th</sup> percentile and maximum values of B factors of atoms in the group. The column labelled ‘Q< 0.9’ lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors(Å <sup>2</sup> )	Q<0.9
2	UZ4	E	4	13/14	0.94	0.08	20,22,24,25	0
2	UZ4	D	4	13/14	0.96	0.07	20,23,26,27	0

### 6.3 Carbohydrates [i](#)

There are no monosaccharides in this entry.

### 6.4 Ligands [i](#)

In the following table, the Atoms column lists the number of modelled atoms in the group and the number defined in the chemical component dictionary. The B-factors column lists the minimum, median, 95<sup>th</sup> percentile and maximum values of B factors of atoms in the group. The column labelled 'Q< 0.9' lists the number of atoms with occupancy less than 0.9.

Mol	Type	Chain	Res	Atoms	RSCC	RSR	B-factors( $\text{\AA}^2$ )	Q<0.9
5	DMS	B	501	4/4	0.88	0.16	45,48,50,61	0
3	GOL	A	502	6/6	0.88	0.24	42,57,61,61	0
3	GOL	A	501	6/6	0.92	0.18	34,41,42,51	0
4	NA	A	503	1/1	0.94	0.09	36,36,36,36	0

### 6.5 Other polymers [i](#)

There are no such residues in this entry.